

Appendix C: Price-Demand Dynamics in the Natural Gas Market

Supply limitations have been the primary cause of recent high and volatile natural gas prices. The increase in demand for gas during the 1990's is also a contributing factor. The North American natural gas market currently has very little excess production capacity (see Figure 3.6), and has been unable to add excess production capacity despite recent record high prices. As a consequence the relationship between supply and price has become relatively *inelastic*, meaning that a large price increase is necessary to bring new supply to market. Natural gas demand has also become relatively inelastic as more electric power generation has become gas-fired. Natural gas use is now dominated by space heating in commercial and residential sectors and in the power generation sector, creating a circumstance(s) with few alternatives when electric power or heat are needed. Inelastic supply and demand creates a situation where small increases in demand, or decrease in supply, can cause a large increase in price, before supply and demand are brought into balance again. Figure C1 below illustrates how the North American natural gas market has moved from one that was demand limited (elastic portion of supply curve) to supply limited market (inelastic portion of supply curve). The movement from S1 to S2 illustrates the long-term decrease in excess production capacity, while movement from D1 to D2 illustrates the recent increase in gas demand. As indicated in Figure C1, the equilibrium price has moved from Eq. 1 to Eq. 2. Note, Figure C1 is a hypothetical supply-demand presentation and does not represent actual measured supply or demand curves.

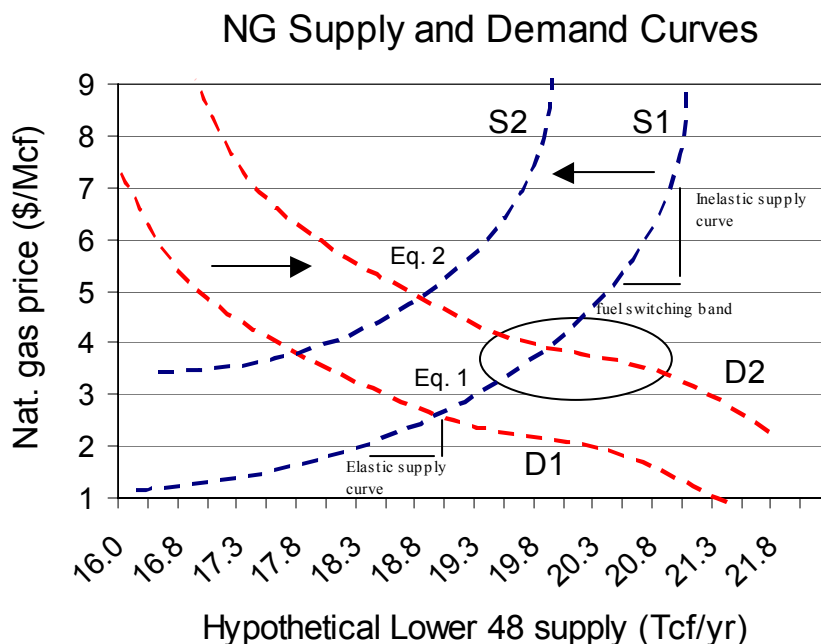


Figure C1: Hypothetical Supply and Demand Curves.

For the market to balance again, high natural gas prices, which lead to small reductions in gas demand, are necessary. The reduction in demand is dependent on how long high gas prices persist, and the availability of substitutes for natural gas. Reductions in demand

that cause the equilibrium price for natural gas to be lower, can be broadly grouped in two categories. *Demand destruction*, which is a temporary or permanent phenomena that refers to the shutdown or relocation of energy intensive industrial users due to prolonged high gas prices, and *Demand reduction*, which can be more temporary in nature and refers to fuel switching and savings from non-permanent conservation and efficiency efforts. Note that some analysts put efficiency in the demand destruction category.

In the residential, commercial and even the electrical generation sector, short-term (less than two years) natural gas demand is relatively inelastic, that is consumption does not decrease or increase markedly as price increases or decreases. Over the long-term (more than two years) natural gas demand is more elastic and will respond to sustained high prices. The National Energy Modeling System used by the U.S. Department of Energy and others use short-term price elasticity's of -0.24 to -0.28 and long-term values of -0.33 to -0.51: where elasticity = percent use reduction / percent price increase. Following a sustained gas price increase, demand will be gradually reduced as a result of efficiency upgrades, which take the form of new appliances or equipment, upgrades or design improvements for buildings, and conservation, which generally refers to behavioral changes such as reduced use of heating, cooling and lighting.

The industrial sector differs from the three sectors mentioned above in that its short-term natural gas demand is slightly more responsive (more elastic) to the price increase. Industrial price-demand responsiveness takes two forms. The first form of natural gas demand reduction comprises efficiency and conservation efforts, such as upgrading equipment and some behavioral changes. The second type includes temporary fuel switching that some industrial operations are capable of on relatively short notice. During the natural gas price spikes of 2001 and 2003, a significant number of industrial gas consumers switched to distillate or residual oil.

In the industrial sector, high gas prices have also resulted in demand destruction, the temporary or permanent shuttering of operations in the most energy intensive industries. Also included in this category is permanent fuel switching. Demand destruction often involves the relocation of the industrial operation to another country where energy is significantly less expensive. Usually there are multiple factors (labor costs, market access, regulations, etc.) that cause a business to relocate an industrial operation, making it difficult to assess the level of demand destruction that is caused solely by higher energy prices.

A brief discussion of demand destruction, fuel switching, weather, and efficiency and conservation and their estimated impacts on natural gas demand are presented below.

Demand destruction

Demand destruction refers to the shut down or relocation of energy intensive industrial users due to prolonged high gas prices and typically applies to those industries that are heavy users of natural gas, either as a feedstock or as an energy input. The industries most susceptible to demand destruction are the fertilizer and the chemical industries.

The fertilizer industry synthesizes ammonia and urea, which are frequently combined with other key ingredients (potassium and phosphorus compounds) to make fertilizer. Natural gas can account for 90 percent of the cost of producing ammonia, so high natural gas prices directly impact the price of fertilizer, and the competitiveness of the U.S. industry. Representatives of the fertilizer industry state that recent high natural gas prices have caused 20 percent of fertilizer plants to permanently shut down and another 25 percent to idle their production (Knight Ridder Tribune Business News, 2003). The recent (2001-03) demand destruction in the fertilizer industry represents slightly more than 1 percent, or 0.6 Bcf/day, of U.S. natural gas consumption (Denhardt, 2003). Foreign producers with significantly cheaper natural gas hold a clear competitive advantage in this industry.

The chemical industry manufactures chemical precursors such as ethylene, propylene, and methanol, which are used primarily by the chemical and plastic manufacturing industries to form more complex compounds. Natural gas is often used as a feedstock and energy source in the production of these precursor chemicals. During the late 1970s, in the face of high oil prices, the American chemical industry shifted away from petroleum naphtha to cheaper natural gas as a feedstock and had held a competitive advantage relative to foreign competition. This advantage began to fade in 2000 with the first natural gas price spike, and has turned into a clear disadvantage in 2003 as North American gas prices have decoupled from world oil prices. It is unclear how much production has been lost due to high natural gas prices, but anecdotal evidence suggests that several plants have closed and a number of others have curtailed operations. Countries with large underutilized natural gas reserves, such as Russia or Saudi Arabia, hold a clear advantage relative to United States, Asian and European producers and may eventually dominate the chemical precursor industry.

To help preserve the U.S. industry the American Chemical Council and others have recently promoted legislation that would require natural gas pipeline businesses to strip out all liquefiable natural gas compounds (primarily ethane, propane and butane) and make these compounds available to the chemical industry (Chemical and Engineering News, 2003). Dow Chemical, which owns significant port properties in Louisiana and Texas, is likely to participate in the building of a LNG receiving terminal to provide its operations with a moderately expensive, but reliable source of natural gas. Smaller and less strategically situated chemical companies may not be able to use LNG importation as an option.

The Northwest has few fertilizer or chemical businesses and will not be significantly impacted directly. However, farmers and manufacturers that use the products of these industries will be impacted by the higher prices for intermediate products.

Fuel switching

Fuel switching, or fuel substitution, is a means by which businesses that use large amounts of fossil fuel energy sources can mitigate high costs for a particular fuel. Fuel switching is not only a valuable option for industrial gas consumers, but for society as a whole since removing even a small fraction of industrial gas use can result in a noticeable

price drop that also benefits commercial and residential gas consumers. In the last several decades, air pollution requirements have greatly reduced fuel-switching capability in the industrial and electrical generating sectors.

While in theory it is possible to switch between numerous fossil fuels, the cost of equipment changes restrict fuel switching to changes between natural gas and distillate fuels, such as diesel, and low sulfur residual oil. A small but significant fraction of gas-fired power plants and a larger fraction of industrial boilers are still able to switch between natural gas and distillate fuels when price differentials become large enough. Fuel switching is primarily limited to older gas-fired power plants and boilers, which often maintain a limited backup supply (typically one or two weeks) of distillate or residual oil. Newer gas-fired power plants and boilers are designed to run almost exclusively on natural gas. In addition, newer power plants and boilers have air pollutant emission constraints that prevent them from converting their equipment to run on distillate fuel. While some analysts have stated that the fuel switching potential is as much as 4 Bcf/day (6.5 percent U.S. average daily gas consumption), it is actually more in the range of 1 to 2 Bcf per day (Michot-Foss, 2003). Though small, a reduction in consumption of 1 to 2 Bcf/day (equivalent to a few percent) can have a marked impact on short-term prices, in a tight market. Figure C2 below illustrates the price points at which plant shutdowns or fuel switching occur, and the estimated volume of daily gas usage that is avoided.

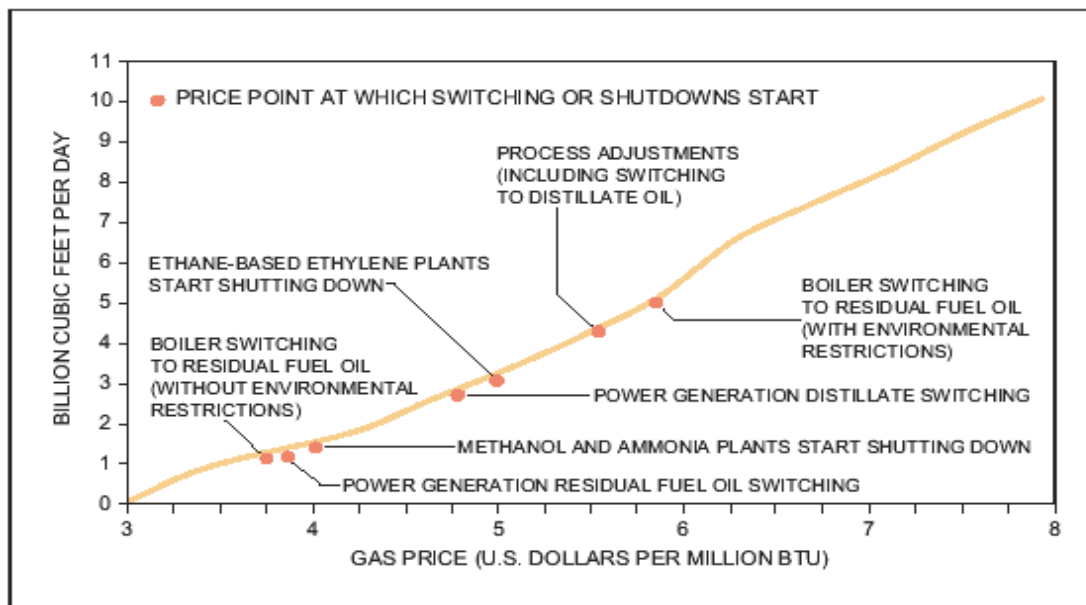


Figure C2: Industrial and power generation natural gas flexibility: 2002 prices.

Source: NPC, 2003

In the past the ability to switch between natural gas and distillate or residual oil insulated the nation from petroleum or natural gas supply shocks. As petroleum derived fuels have been displaced by natural gas for use in the residential, commercial and particularly the industrial sector, we have lost much of the flexibility of fuel switching. In addition, the

limited amount of fuel switching ability left in our economy has already occurred following the two recent gas price spikes (Weisman, 2003). The demand response elasticity afforded by fuel switching will not be available to moderate potential future price increases.

Conservation and efficiency

Industrial, commercial and residential users will respond to high natural prices by pursuing conservation and efficiency improvements that they otherwise would not have pursued. In the commercial and industrial sectors, efficiency measures would include replacement or upgrading of older natural gas equipment (heaters, boilers, etc.), while in the residential sector efficiency measures would consist of switching to more energy efficient heaters and appliances. Reductions in gas usage from efficiency measures are for the most part permanent. It is estimated that short-term efficiency measures can reduce natural gas consumption by 0.3 to 0.5 Bcf/day (Michot-Foss, 2003).

Conservation measures are more behavioral in nature and result primarily in temporary reductions in gas usage. Conservation efforts would occur in all sectors and include reducing heating demand in the winter by lowering thermostat settings, and reducing electricity used to meet air conditioning requirements in the summer. Short-term conservation efforts have the potential to reduce natural gas consumption by 0.5 to 1.5 Bcf/day, or 0.8 to 2.4 percent (Ibid).

Extent of recent demand reduction and demand destruction

While it is difficult to directly estimate the reduction in natural gas usage caused by current high prices, there is anecdotal evidence to support claims of at least a 5 percent reduction in gas demand. In recent testimony before the U.S. House Energy Committee, information was presented that indicated a reduction in demand of 3 to 6 Bcf/day, equivalent to roughly 5 to 10 percent of U.S. natural gas consumption, could be anticipated (Ibid). Energy analysts Andy Weismann (Energy Ventures Group) and Ron Denhardt (Strategic Energy & Economic Research, Inc.) suggest that following the 2000-01 natural gas price spike, demand was reduced by 6 Bcf/day, with a 2 Bcf/day reduction from fuel switching alone. While some of the demand reduction was probably due to the 2001-02 recession, it seems plausible that in the short run 3 Bcf/day or 5 percent of U.S. consumption was shed during the course of the initial (2000-01) gas price spike.

The recent series of record gas storage injections, that exceeded the five-year average weekly injection rates by 15 to 30 Bcf, are suggestive of an additional demand reduction of roughly 3 Bcf/day for 2003. This modest reduction in gas demand has allowed short-term spot prices to decline by roughly 20 percent; evidence that in a tight market a small reduction in gas demand can dramatically reduce price. Many energy analysts attributed the demand reduction in 2003 to further fuel switching and demand destruction in the industrial sector.

Weather as a wild card

Demand reduction and demand destruction are difficult to assess on a short-term monthly or seasonal basis. A recent examination of consumption (by sector) and storage data reveals a different story about the importance of demand reduction and demand destruction in moderating gas demand (Weisman, 2003). See Table C1 below.

Table C1: Difference in gas storage and use for electricity: 2003 vs. 2002.

Month	Difference in gas used to generate electricity: 2003 – 2002.	Difference in working gas storage: 2003-2002
April	-72 Bcf	+ 25 Bcf
May	-37 Bcf	+ 95 Bcf
June	-133 Bcf	+ 128 Bcf
July	-133 Bcf	+ 96 Bcf
Total	-375 Bcf	+ 344 Bcf

The gas savings in the electricity sector were attributable to a reduction in generation (62 percent savings), more efficient gas-fired power plants (21.5 percent of savings) and fuel switching (16.5 percent savings). In the fall of 2003, a milder hurricane season and a warm October also made more gas available for storage. There are two messages from the above analysis. First, industrial demand reduction/destruction probably didn't account for the increased gas storage injections during 2003. Second, we had a bit of luck in the summer of 2003 as the weather was mild, which helped ease the high gas prices. Future summers maybe much warmer and increased electricity generation will eliminate or reverse the small storage/production surplus shown in Table C1, which will then put upward pressure on gas prices.